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Statement of
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Subcommittee on Space and Aeronautics
Committee on Science
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Mr. Chairman and Members of the Subcommittee, thank you for this opportunity to appear before you today to discuss the status of the Next Generation Air Transportation System (NGATS). NASA is committed to working with our partners at the Joint Planning and Development Office (JPDO) to provide the high-quality research and technical excellence required to develop the NGATS.

NASA's Aeronautics Research Mission Directorate (ARMD) is currently undergoing a comprehensive restructuring to ensure that we have a strategic plan in place that enables us to pursue long-term, cutting-edge research for the benefit of the broad aeronautics community. The three principles guiding this restructuring are as follows: 1) we will dedicate ourselves to the mastery and intellectual stewardship of the core competencies of aeronautics in all flight regimes; 2) we will focus our research in areas appropriate to NASA's unique capabilities; and 3) we will directly address the fundamental research needs of the NGATS while working closely with our agency partners in the JPDO.

Regarding the third principle, one of the research challenges that NASA will directly address will be that of Air Traffic Management (ATM). While our current ATM system has served the country well, there are critical shortcomings that prevent it from meeting anticipated future demands. The future ATM system must be scalable to support increased capacity as well as flexible to accommodate the wide variety of air vehicles that will fly within the system. New concepts and technologies must be conceived and developed that will completely transform the overarching structure that will coordinate thousands of vehicles operating in the national airspace at any given time.

However, it is important to recognize that the challenges we face in developing the NGATS are not limited to ATM alone. For our air transportation system to continue to

function, future air vehicles will need to address substantial noise, emissions, efficiency, and performance challenges. These are issues that cannot be worked in isolation – a holistic approach to vehicle design will be required in order to address multiple and often conflicting design requirements. Furthermore, as both the vehicles and the airspace system become increasingly complex, we must make a commitment to conduct the research necessary to ensure that our high safety standards are not compromised.

Therefore, NASA's ARMD will conduct the long-term, cutting edge research that will be necessary to ensure revolutionary capabilities for both the air vehicles of the future as well as the air transportation system in which they will fly. Gone are the days when one can design innovative vehicles without consideration of the airspace, and the converse is, of course, equally true. We have four major programs – the Airspace Systems Program, the Aviation Safety Program, the Fundamental Aeronautics Program, and the Aeronautics Test Program – each of which contributes to the research needs of the future air transportation system, as described in more detail below. NASA has constructed a balanced research portfolio that draws upon our NASA-unique capabilities to address ATM, vehicle, and safety-related research challenges, all of which must be worked in order for the NGATS vision to be realized. Budget allocations across the programs are based upon the long-term research needs and goals of each program as well as the capabilities currently available at each of the research centers. Funding levels among the programs have been balanced to ensure that our intellectual stewardship of the core competencies of aeronautics is not compromised.

ARMD has interacted closely with the JPDO during the past several months to ensure proper alignment of our research plans with the needs of the NGATS. Specifically, members of the JPDO provided feedback regarding the content of our preliminary research plans in all of our programs before we presented them publicly at an American Institute of Aeronautics and Astronautics conference in January 2006. Our researchers at the NASA centers are currently developing detailed technical proposals that build upon that preliminary work. The proposals will include integrated multi-year research plans, with milestones that are challenging but also technically sound. These proposals will undergo a rigorous review by several government experts, including members of the JPDO, to ensure that the plans are technically credible and well-aligned with the NGATS vision. This level of coordination and cooperation will remain an ongoing element of the ARMD strategic partnership with the JPDO.

Finally, in addition to conducting research that directly addresses the challenges of the NGATS, we have placed a strong emphasis on active participation in the JPDO itself, providing personnel, analysis tools, and funds to directly support JPDO functions and activities. NASA is actively involved in all the organizational elements of the JPDO, from the Integrated Product Teams (IPTs) and the Evaluation and Analysis Division (EAD) up through the Senior Policy Committee (SPC), which oversees the work of the JPDO and is chaired by the Secretary of Transportation.

Airspace Systems

The objective of the Airspace Systems Program (ASP) is to develop revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of our National Airspace System (NAS) – an objective that is clearly aligned with the JPDO’s vision of the NGATS. The ASP consists of two projects: the NGATS ATM: Airspace Project and NGATS ATM: Airportal Project.

The NGATS ATM: Airspace Project will develop and explore fundamental concepts and integrated solutions that address the optimal allocation of ground and air automation technologies necessary for the NGATS. The project will focus NASA’s technical expertise and world-class facilities to address the question of where, when, how, and the extent to which automation can be applied to moving aircraft safely and efficiently through the NAS. Research in this project will address Four-Dimensional (4D) Trajectory Operations including advances in the science and applications of multi-aircraft trajectory optimization that solves the demand/capacity imbalance problem while taking into account weather information and forecast uncertainties and keeping aircraft safely separated. Our research will develop and test concepts for advanced Traffic Flow Management to provide trajectory planning and execution across the spectrum of time horizons from “strategic planning” to “separation assurance.” We will also conduct research to explore Dynamic Airspace Configuration that addresses the technical challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demand and meets changing constraints of weather, traffic congestion, and a highly diverse aircraft fleet. Ultimately, the roles and responsibilities of humans and automation touch every technical area and will be addressed thoroughly.

Working in close collaboration with the NGATS ATM: Airspace Project, the NGATS ATM: Airportal Project will develop and validate algorithms, concepts, and technologies to increase throughput of the runway complex and achieve high efficiency in the use of airportal resources such as gates, taxiways, runways, and final approach airspace. Currently, the growth of air traffic demand and fleet diversity is causing the operational volume at hub airports to rapidly approach their maximum capacity. NASA research in this project will lead to development of solutions that safely integrate surface and terminal area air traffic optimization tools and systems with 4D trajectory operations. To support super-density and equivalent visual operations, NASA will also conduct research in wake hazard sensing and prediction.

Substantial leveraging of research across the two projects will occur in areas such as computational science and engineering, applied mathematics for system optimization, trajectory design and conformance, automation design, and adaptive air/ground automation. Ultimately, the results of the two projects will be integrated to ensure gate-to-gate solutions that are aligned with the NGATS needs.

Aviation Safety

Through the vigilance of industry and government, the U.S. Air Transportation System is widely recognized as one of the safest transportation systems world wide. Looking toward the future at the projected increases in air traffic and future system capabilities, this vigilance must continue in order for the U.S. to meet both the public expectations for safety and the full realization of the NGATS. To help meet these future challenges, the Aviation Safety Program (AvSP) will focus on developing cutting-edge technologies intended to improve the intrinsic safety attributes of aircraft that will be operating in the evolving NGATS. The four projects in the AvSP are as follows: Integrated Vehicle Health Management (IVHM), Aircraft Aging and Durability (AAD), Integrated Intelligent Flight Deck (IIFD), and Integrated Resilient Aircraft Control (IRAC).

The focus of the IVHM and the AAD projects are to improve the inherent resiliency, life-cycle durability, and maintenance of modern aircraft and associated onboard systems. The IVHM project will conduct research to advance the state of highly integrated and complex flight critical health management technologies and systems. Potential benefits include reduced occurrence of in-flight system and component failures, and onboard systems capable of self-detecting and self-correcting anomalies during a flight that could otherwise go unattended until a critical failure occurs. The AAD project will develop advanced diagnostic and prognostic capabilities for detection and mitigation of aging-related hazards. The research and technologies to be pursued will decrease the susceptibility of current and next generation aircraft and onboard systems to pre-mature deterioration and failures, thus greatly improving vehicle safety and mission success.

New capabilities envisioned for the NGATS such as Super Density Operations, Aircraft Trajectory-Based Operations, and Equivalent Visual Operations pose potential safety challenges for ensuring optimum crew workload distribution and application of advanced flight critical automatic and autonomous systems. The AvSP will conduct research on advanced vehicle-based capabilities to address potential unintended consequences that could compromise vehicle or system safety. The IIFD project will pursue flight deck related technologies that will ensure that crew workload and situation awareness are both safely optimized and adapted to the NGATS future operational environment. The IRAC project will conduct research to advance the state of aircraft flight control automation and autonomy in order to prevent loss-of-control in flight, which is the accident category that currently has the highest number of aircraft accidents. Taking into account the advanced automation and autonomy capabilities as envisioned by NGATS, the research will pursue methodologies to enable an aircraft to automatically detect, avoid, and/or safely recover from an unusual attitude or adverse condition.

Fundamental Aeronautics

The Fundamental Aeronautics Program (FA) is dedicated to the mastery and intellectual stewardship of the core competencies of aeronautics across all flight regimes. Researchers in FA will conduct cutting-edge research across multiple disciplines

including aerothermodynamics, acoustics, propulsion, materials and structures, computational fluid dynamics, and experimental measurement techniques. The focus of this research is the generation of pre-competitive high-fidelity data and design tools that will be applicable across all flight regimes including subsonics (both fixed and rotary wing), supersonics, and hypersonics.

Future aircraft in the NGATS will need to be quiet and clean to meet stringent noise and emissions regulations. Additionally, these air vehicles will need to meet challenging performance requirements to make them economically viable alternatives to the existing fleet. A holistic approach to vehicle design will therefore be required in order to address multiple and often conflicting design requirements. This in turn requires substantial improvements in our current ability to predictively design aircraft.

Today's design tools can be used for incremental improvements to existing engines and airframes. However, because they are based on empirical knowledge obtained over a long history of small design improvements, they cannot be used to design radically new engines and air vehicles. A key focus of FA will be the development of physics-based Multidisciplinary Analysis and Optimization (MDAO) tools that will enable the rapid evaluation of new concepts and technologies. These tools will accelerate the application of new technology to a wide array of air vehicles. This revolutionary approach will only be possible if we make a firm commitment to the pursuit of knowledge across all of the aeronautics disciplines that are critical in the design of air vehicles.

We must acknowledge that the challenges of the future are so substantial that we must not falter in our commitment to a long-term investment in cutting-edge research. We must conduct high quality research to address fundamental scientific and engineering issues in such areas as noise source characterization, combustion chemistry, alternative fuel chemistry, turbulence modeling, materials design, and active flow control. Only by taking a strategic and comprehensive approach to air vehicle research will we be able to assure the future of air transportation in this country.

Aeronautics Test Program

NASA has established the Shared Capability Asset Program (SCAP), which includes the Aeronautics Test Program (ATP). The ATP ensures the long-term availability and viability of the set of aeronautics test facilities that NASA, working with the Department of Defense (DOD) and the U.S. aircraft industry, considers to be of national strategic importance. Several of these facilities will be critical in supporting research that directly addresses the research needs of the NGATS. These include ground test facilities that are used to simulate adverse weather conditions, to measure engine and airframe noise, and to measure engine emissions.

Evaluation and Analysis

In addition to conducting research that directly addresses the challenges of the NGATS, NASA provides a direct role in evaluating and analyzing proposed systems-level NGATS concepts and architectures. NASA personnel are key members of the JPDO Evaluation and Analysis Division (EAD), which is now an inherent entity within the JPDO. Many of the sophisticated simulations and models being used by the EAD to evaluate concepts to ensure that we will be developing a system that will most efficiently and effectively meet the needs of tomorrow's air transportation system have been developed by NASA. Likewise, NASA employs these tools to evaluate the impacts of its own research program upon the national objectives for transformation.

Challenges for the JPDO and the Way Ahead

The JPDO's vision for the NGATS is revolutionary and ambitious and therefore faces some significant challenges. Programmatically, the most obvious challenge is that of preserving the strong cooperation that currently exists among the member agencies for the next twenty years. Such cooperation is often personality-driven, but it must be sustained as individuals in each organization come and go. It is therefore imperative that the JPDO remains focused on close cooperation at all levels. Currently, this is accomplished at the technical level through the multi-agency IPTs and the joint architecture council. From an oversight perspective, a senior interagency board is in place to support the SPC and ensure that high-level leadership is engaged in all critical aspects of the NGATS development. All member agencies of the JPDO must remain committed to supporting these processes, and the processes themselves must continue to evolve as the NGATS development matures.

A perhaps less obvious but equally important challenge is the necessity to not compromise technical integrity as the JPDO faces the reality of maintaining "advocacy" among stakeholders. In other words, the JPDO must be willing to adjust technical goals and milestones if research results determine that it is necessary to do so. The JPDO cannot succumb to political pressures of overselling or overstating system-level goals that are found to be technically or economically infeasible. A commitment to technical integrity will be critical to the long-term success of the JPDO.

Technically, the most important near-term challenge is the development of the Concept of Operations and the Enterprise Architecture. This step is necessary to establish system-level requirements that are clear, verifiable, and attainable. While the capabilities articulated in the JPDO's NGATS vision have enabled each agency to vector its research portfolio in the right direction, the establishment of detailed system requirements will allow each member agency to better refine its R&D plans. Given that every agency has budget constraints, and always will, the establishment of an Enterprise Architecture will be critical to ensure that each agency prioritizes its R&D investments in the manner that

provides the maximum return on investment for the JPDO. The JPDO intends to provide a preliminary Enterprise Architecture by the summer of 2006.

One of the significant “mid-to-long-term” technical challenges will be the implementation of automation platforms for strategic 4D trajectory management and tactical separation assurance. While NASA will need to provide sustained and focused research in these areas, ultimately it will be the JPDO that must manage the transfer of the technology to the FAA for system development and implementation.

Conclusion

In conclusion, NASA’s ARMD is investing in long-term, cutting-edge research in areas that are appropriate to NASA's unique capabilities in order to enable the NGATS vision. We have aligned our research portfolio to meet this challenge with an efficient allocation of resources and an unwavering commitment to technical excellence.